

## SECTION 30

### CULVERTS

#### 1.30.1 WATERWAY OPENINGS

- (a) All matters concerning size of waterway openings shall be in liaison with the Hydraulic Design Unit of the Bureau of Civil Engineering.
- (b) Reference is directed to Section 17 of the NJDOT Procedures Manual concerning Permit acquisition. Preliminary bridge drawings (594 by 841 millimeters) will not be accepted until applicable Permit requirements have been completed.

#### 1.30.2 HYDRAULIC AND HYDROLOGIC DATA

- (a) The following tabulation with complete information shall be shown on preliminary bridge plans and final bridge plans:

HYDRAULIC AND HYDROLOGIC DATA		
DRAINAGE AREA (KM <sup>2</sup> )		
DESIGN DISCHARGE (M <sup>3</sup> /S)		
DESIGN WATER SURFACE ELEVATION (M)		
ENERGY LINE ELEVATION (M)		
FREQUENCY	50 YR.	100 YR.

#### 1.30.3 GENERAL

- (a) For reinforced concrete box culverts, the horizontal joint between the walls and top slab shall be designated OPTIONAL CONSTRUCTION JOINT when the height between the upper and lower horizontal joints is 2.4 meters or less. The construction specifications provide that if the Contractor elects to omit the joint, he shall delay placing the concrete in the top slab for at least 2 hours after the concrete in the walls has been placed.

In addition, the joint between the invert slab and the side walls shall be detailed as a construction joint, and the invert slab concrete shall achieve a minimum compressive strength of 21 megapascals prior to the construction of the remainder of the culvert.

- (b) Wingwall footings at their junction with the invert slab shall be detailed without a construction or contraction joint so that the footing concrete is placed monolithically with the invert slab.
- (c) Large storm drains (600 millimeters diameter or larger) shall not be discharged through walls of culverts in order to minimize adverse hydraulic characteristics.

The Structural Design Engineer shall obtain an approval from the Manager, Bureau of Structural Engineering and concurrence from the Manager, Hydraulic Design Unit if not placing drainage pipes through a culvert wall provides excessive burden.

- (d) The illustration on Guide Plate 3.12-4 shows guidelines for establishing excavation payment limits for roadway and bridge items of work.
- (e) Guide Plates 3.12-1 and 3.12-2 provide guidelines for developing uniform details on contract drawings for single and twin cell box culverts, respectively. The designer shall design and detail the culvert on the plans assuming cast-in-place concrete construction.
- (f) The Special Provisions for select projects (such as where staging is required or where limited construction time is essential to restore normal vehicular or rail traffic) may require precast culvert construction.

In such cases, the Structural Design Engineer shall select opening sizes for the cast in place concrete culvert which are obtainable in standard precast concrete sections. A partial listing of standard precast sizes are shown below. The designer shall contact various local precasters to obtain the latest information on standard precast culvert sizes that are commercially available. Approval from the Manager, Bureau of Structural Engineering and Manager, Hydraulic Design Unit shall be obtained prior to proceeding with the Final Design.

#### **Height by Width in Millimeters**

1 200 by 2 400	1 350 by 2 400	1 500 by 2 400	1 650 by 2 400	1 800 by 2 400
1 200 by 3 000	1 350 by 3 000	1 500 by 3 000	1 650 by 3 000	1 800 by 3 000
1 200 by 3 600	1 350 by 3 600	1 500 by 3 600	1 650 by 3 600	1 800 by 3 600
1 200 by 4 200	1 350 by 4 200	1 500 by 4 200	1 650 by 4 200	1 800 by 4 200
1 200 by 4 800	1 350 by 4 800	1 500 by 4 800	1 650 by 4 800	1 800 by 4 800
1 200 by 5 400	1 350 by 5 400	1 500 by 5 400	1 650 by 5 400	1 800 by 5 400
1 200 by 6 000	1 350 by 6 000	1 500 by 6 000	1 650 by 6 000	1 800 by 6 000
1 200 by 6 600	1 350 by 6 600	1 500 by 6 600	1 650 by 6 600	1 800 by 6 600

(g) Provisions for a low flow fish passage in the form of a fish trough or other means may be required for culverts in certain locations. The NJDOT Project Manager will notify the designer of a need for a low flow fish trough during the permit review process prior to the development of the Final design. For specific requirements and exceptions refer to N.J.A.C. 7:13-3.14, fish passage in the "Technical Manual for Stream Encroachment" from the New Jersey Department of Environmental Protection.

(h) In order to increase the inlet performance and for improved flow through the culvert, the bottom of inner top slab and walls edges shall be beveled as follows at the entrance of the culvert:

- (1) For single cell box culverts, a 45 degree bevel of 13 millimeters per

meter of culvert clear height shall be provided for the top slab and bottom edge of the culvert entrance. A 45 degree bevel of 13 millimeters per meter of culvert clear width shall be provided for both side walls and inside edges of the culvert waterway entrance.

- (2) For twin cell box culverts, in addition to the bevels specified above, the center wall shall have a 45 degree of 63 millimeters on both sides. This is based on a minimum 200 millimeter wall thickness. For every 26 millimeter increase in the center wall thickness, there shall be a 13 millimeter increase of the bevel on both sides.

#### **1.30.4 DESIGN CRITERIA FOR PRECAST REINFORCED CONCRETE BOX SECTIONS FOR CULVERTS**

- (a) Precast reinforced concrete box sections shall not be used where the top slab is to be used as a riding surface.
- (b) Precast reinforced concrete box culverts shall be designed by the service load design method (allowable stress design) in accordance with Division 1, Section 17.7 of the AASHTO Standard Specifications for Highway Bridges (including current Interims), as modified by SECTION 3 of this Manual.
- (c) Live load shall conform to AASHTO MS18 + 25% (MS22.5) or an alternate military loading of two axles 1.2 meters apart with each axle weighing 108 kilonewtons, whichever produces the greatest stress. For Non-Federal Aid Highways with Average Daily Truck Traffic (ADTT) less than 500, alternative design criteria, as specified in Section 44 of this Manual, shall be used.
- (d) Dead load shall include 1.2 kPa for future application of a 50 millimeter thick wearing surface when the earth fill above the top of culvert is less than 600 millimeters.
- (e) Headers, cut-off walls, wingwalls, footings and aprons shall be designed by the allowable stress design method in accordance with the AASHTO Standard Specifications for Highway Bridges (including current interims) as modified by Section 3 of this Manual.
- (f) Concrete for precast concrete elements shall be Class "P" in accordance with Table 914-2 of the NJDOT Standard Specifications, and have a minimum design compressive strength of  $f_{\bar{c}} = 35$  megapascals.
- (g) The minimum concrete cover over the circumferential reinforcement shall be 40 millimeters except on the exterior side of the top slab where it shall be 50 millimeters.
- (h) The wall thickness for precast culverts shall be a minimum of 205 millimeters. The top and bottom slab thickness shall be a minimum of 255 millimeters.
- (i) A flexible watertight rubber gasket shall be provided at the joint between the

precast units. The gasket shall be continuous around the circumference of the joints. Details of the transverse joint between the culvert sections shall be provided on the plans.

- (j) A coarse aggregate layer shall be provided under the precast reinforced concrete box culvert sections. The depth of the coarse aggregate layer shall be a minimum of 600 millimeters. It shall extend 300 millimeters on each side of precast reinforced concrete box culvert section.
- (k) A waterstop shall be provided to prevent water from entering vertical joints between the end of precast culvert sections and any cast-in-place appurtenances such as wingwalls, cutoff walls, aprons and cast-in-place culvert end sections.
- (l) Two rows of threaded inserts or bar extensions (longitudinal tie bolts) shall be provided in the end culvert section to facilitate the attachment of the culvert end section to the wingwalls. A detail of this connection shall be provided on the plans.
- (m) As per item (l), provide the same detail, if applicable, for the headwall attachment.
- (n) If precast concrete units are used in parallel for multicell installations, the parallel units shall be placed a maximum of 150 millimeters apart. The 150 millimeter space between the units shall be filled in conformance with the Special Provisions. The purpose of this procedure is to ensure a positive means of lateral support between the parallel precast units.
- (o) The use of precast concrete end sections, including headwalls, will be reviewed and approved on a bridge by bridge basis.

However, precast end sections shall not be used when the skew angle requirements result in a situation where the short wall of a precast end section is less than 900 millimeters.

If approved for use, adequate provisions shall be made for cast in place appurtenances such as wingwalls, aprons and cutoff walls.

- (p) The top mat of reinforcement, and ties, in the top slab shall be corrosion protected when the earth fill over the precast culvert is less than 600 millimeters. The use of epoxy coated and galvanized reinforcement shall not be mixed.
- (q) Lifting devices or holes will be permitted in each box section for the purpose of handling and erection. All lifting holes shall be filled with nonshrink grout, after the grout has cured, the area shall be coated with an epoxy waterproofing seal coat.
- (r) Placement of precast units:
  - The precast units shall be pulled against the prior installed section such that an adequate seal is obtained between the two connecting units and the

rubber gasket.

- Prior to backfilling, a 600 millimeter wide strip of filter fabric shall be placed over the top and side transverse joints.
  - To provide continuity and concrete shear transfer between the precast box sections, a longitudinal tie rod or prestressing strand shall be placed in position through a 38 millimeter diameter hole.
  - Four (4) longitudinal ties, one in each corner of the precast section, shall be provided.
  - Longitudinal ties that are used to tie the precast units together shall be 19.1 millimeter diameter high tensile strength steel bars conforming to AASHTO M 275M (ASTM A 722) or 13 millimeter 7 wire Grade 1860 strands conforming to AASHTO M 203M (ASTM A 416).
  - No splices are permitted in the strands. Bars shall be galvanized in accordance in accordance with AASHTO M 111.
  - End anchorages (nuts, washers and anchor plates) shall be compatible with the tie rod system and shall be galvanized in accordance with AASHTO M 111.
  - The anchorages and end fittings for the 13 millimeter 7 wire strand and the corrosion protection method shall be detailed on the plans.
  - Each tie rod shall be stressed to a tension of 133 kilonewtons.
  - After tensioning, the exposed ends of the ties shall be removed so that no part of the ties, or of the end fittings, extend beyond a point 25 millimeters inside the anchorage pocket.
  - All hardware associated with the end anchorage systems shall be galvanized. After tensioning has been completed the exposed parts of the end fittings shall be coated with two coats of bituminous paint.
  - If hand holes are used for the installation of longitudinal ties, they shall be spaced appropriately.
- (s) The precast reinforced concrete culvert units shall be manufactured in steel forms and steam cured in conformance with Subsection 501.12 (Subpart 17) of the NJDOT Standard Specifications.
- (t) Precast reinforced concrete culvert units shall not be shipped until 72 hours after fabrication and the 28 day compressive strength requirement is met.
- (u) Precast reinforced concrete culvert units shall be given one coat of an epoxy waterproofing seal coat on the exterior of the roof slab. This coating shall be provided at the precasting plant. In addition, any top slab hand hole pockets or lifting holes, which are grouted in the field, shall received one coat of epoxy waterproofing seal coat after the grout has properly cured.
- (v) All working drawings shall be on 594 by 841 millimeter sheets and in the format specified in Subsection 105.04 of the NJDOT Standard Specifications.
- (w) The materials used for precast concrete box culverts shall conform to the current edition of the New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction and applicable sections of the Special Provisions.

Reinforcement steel shall conform to AASHTO A615M, Grade 420. Welded deformed steel wire fabric, conforming to AASHTO M221M/M221 and having a

diameter of at least 9.5 millimeters may be substituted for deformed bars.

Longitudinal tie bolts, where utilized, shall conform to the requirements of current ASTM designation A307 and shall be hot-dip galvanized after fabrication, including threading in accordance with the requirements of current ASTM A153.

Concrete for precast culverts shall conform to Section 914 of the NJDOT Department of Transportation Standard Specifications for Road and Bridge Construction, except that Coarse aggregate shall be washed gravel or broken stone of Argillite, Granite, Gneiss, Quartzite or Trap Rock, conforming to the requirements of Section 901 and shall be graded as specified for standard size No. 57 or 67.

(x) Reference Subsection 1.30.3(h) for guidelines concerning beveling inner edges of the culvert entrance.